

Claims

1. A phase detection apparatus for generating a phase difference signal for use in a phase lock loop (PLL), the apparatus having a first input for a reference signal, and a second input for a loop feedback signal, the apparatus comprising:
 - 5 a) a first storage element having a clock input, a reset input and an output,
 - b) a second storage element having a clock input, a reset input and an output,
 - c) a logic element for logically combining the outputs of the first and second storage elements, the logic element having inputs coupled to the outputs of the two storage elements and an output coupled to the reset input of the first storage element,
 - 10 d) a delay element coupled to the output of the logic element, the delay element having an output coupled to the reset element of the second storage element,

wherein the reference signal is input to clock input of the first storage element and the loop feedback signal is input to clock input of the second storage element, the provision of

 - 15 the delay at the reset input to the second storage element effecting a delay of a trailing edge of the output of the second storage element relative to a trailing edge of the output of the first storage element.
2. The apparatus as claimed in claim 1 further comprising a second delay element with an input coupled to the output of the logic element, the second delay element having an output coupled to the reset element of the first storage element and wherein the delay introduced by the second delay element to the first storage element is less than the delay introduced by the first delay element to the second storage element.
- 25 3. The apparatus as claimed in claim 1 further including a second delay element coupled between the logic element and the first delay element, the output of the second delay element being coupled to the reset element of the first storage element and the input of the first delay element.
- 30 4. The apparatus of claim 1 wherein the logic element comprises a logic AND gate.
5. The apparatus of claim 1 wherein the two storage elements are flip flops.

6. The apparatus of claim 5 wherein the flip-flops are D type flip flops and further comprise data inputs coupled to a logic high.
7. The apparatus of claim 1 wherein the output of the first storage element and the output of the second storage element are coupled by a first current source having an enable input coupled to the output of the first storage element and a second current source having an enable input coupled to the output of the second storage element, the first and second current sources being coupled to form an output for a phase difference signal.
8. The apparatus as claimed in claim 1 wherein the phase detection apparatus is a tri-state phase frequency detector.
9. The apparatus as claimed in claim 1 wherein the relative delay in the trailing edges is programmable.
10. The apparatus as claimed in claim 9 wherein the relative delay is at least greater than the maximum deviation of the phase of the second storage element's clock input.
11. A phase lock loop apparatus having a reference signal input and an oscillator output, the apparatus comprising:
 - a) a filter element having an input and an output,
 - b) a controllable oscillator device having a control input coupled to the output of the filter element and an output adapted to produce the oscillator output,
 - c) a frequency dividing element having a first input coupled to the output of the oscillator output and an output for producing a feedback loop signal,
 - d) a charge pump having two inputs and an output adapted to provide a phase difference signal as an input to the filter element, and
 - e) a phase detection apparatus having a first input for the reference signal, and a second input for the loop feedback signal, the apparatus comprising:
 - i) a first storage element having a clock input, a reset input and an output coupled to the first input to the charge pump,

- ii) a second storage element having a clock input, a reset input and an output coupled to the second input to the charge pump,
- iii) a logic element for logically combining the outputs of the first and second storage elements, the logic element having inputs coupled to the outputs of the two storage elements and an output coupled to the reset input of the first storage element,
- iv) a delay element coupled to the output of the logic element, the delay element having an output coupled to the reset element of the second storage element, and
- wherein the reference signal is input to clock input of the first storage element and the loop feedback signal is input to clock input of the second storage element, the provision of the delay at the reset input to the second storage element effecting a delay of a trailing edge of the output of the second storage element relative to a trailing edge of the output of the first storage element, the two outputs being coupled to the inputs to the charge pump.
12. The phase lock loop apparatus as claimed in claim 11 wherein the frequency dividing element comprises an interpolator
13. A phase detection apparatus comprising:
- a) a first storage element having a clock input, a reset input and an output,
- b) a second storage element having a clock input, a reset input and an output,
- c) a logic element for logically combining the outputs of the first and second storage element, the logic element having two inputs coupled to the outputs of the two storage elements and an output coupled to the reset input of the first storage element and the reset input of the second storage element, and
- d) a stretching element for effecting a stretching of the trailing edge of the output of one of the first and second storage elements.
14. The apparatus as claimed in claim 13 further comprising:
- a) a delay element coupled to the output of the logic element, the delay element having an output coupled to the reset input of at least one of the first and second storage elements.

15. The apparatus as claimed in claim 14 wherein the output of the delay element is coupled to the reset element of the first storage element.
- 5 16. The apparatus as claimed in claim 14 wherein the output of the delay element is coupled to the reset element of the second storage element.
17. The apparatus as claimed in claim 14 wherein the output of the delay element is coupled to the reset element of both the first and second storage elements.
- 10 18. The apparatus as claimed in claim 13 wherein the stretching element stretches the trailing edge output of the first storage element relative to the trailing edge output of the second storage element.
- 15 19. The apparatus as claimed in claim 13 wherein the stretching element stretches the trailing edge output of the second storage element relative to trailing edge output of the first storage element.
- 20 20. The apparatus as claimed in claim 13 wherein the stretching element is located at the output of the first storage element.
21. The apparatus as claimed in claim 13 wherein the stretching element is located at the output of the second storage element.
- 25 22. The apparatus as claimed in claim 13 wherein the phase detection apparatus is a tri-state phase frequency detector.
23. The apparatus as claimed in claim 13 wherein the delay in the trailing edge is programmable.
- 30 24. The apparatus as claimed in claim 23 wherein the delay is at least greater than the maximum deviation of the phase of the second storage element's clock input.

25. The apparatus as claimed in claim 13 further comprising a second stretching element and wherein the stretching elements effect a stretching of the trailing edge of both of the first and second storage elements' outputs.

26. The apparatus as claimed in claim 13 for use in a phase lock loop having a reference signal and a loop feedback signal and wherein the reference signal is input to the clock input of the first storage element and the loop feedback signal is input to the clock input of the second storage element, and the provision of the stretching element for stretching the trailing edge of the output of one of the first and second storage elements enables the introduction of a compensatory phase offset at the input of the phase detection apparatus when the apparatus is used as a phase frequency detector in a phase lock loop.

27. A phase lock loop apparatus having a reference signal input and an oscillator output, the apparatus comprising:

- a) a filter element having an input and an output,
- b) a controllable oscillator device having an input coupled to the output of the filter element and an output adapted to produce the oscillator output,
- c) a frequency dividing element having a first input coupled to the output of the oscillator output and an output for producing a feedback loop signal,
- d) a charge pump having two inputs and an output adapted to provide a phase difference signal as an input to the filter element, and
- e) a phase detection apparatus comprising:
 - i) a first storage element having a clock input coupled to the reference signal input, a reset input and an output,
 - ii) a second storage element having a clock input coupled to the loop feedback signal, a reset input and an output,
 - iii) a logic element for logically combining the outputs of the first and second storage element, the logic element having two inputs coupled to the outputs of the two storage elements and an output coupled to the reset input of the first storage element and the reset input of the second storage element, and

iv) a stretching element for effecting a stretching of the trailing edge of the output of one of the first and second storage elements, and

wherein the outputs of the first and second storage elements are coupled to the inputs of the charge pump.

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28. The phase lock loop apparatus as claimed in claim 27 wherein the frequency dividing element is coupled to an interpolator.

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29. The phase lock loop apparatus as claimed in claim 27 further comprising a charge pump, the charge pump having a first and a second input, the first and second inputs being coupled to the outputs of the first and second storage elements respectively, the charge pump having an output coupled to the filter element.